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POWER SYSTEMS CALCULATION

Josep Fanals

CITCEA

02/2021

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Sigma approximants

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GridCal

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FGBM + HELM

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Formulation

We define the problem in two steps.

- Admittances side:

$$\begin{cases} I^{l+\frac{1}{2}} - I^{l} = \alpha(V^{l+\frac{1}{2}} - V^{l}), \\ YV^{l+\frac{1}{2}} = I_0 + I^{l+\frac{1}{2}}. \end{cases} \quad \text{(Eq. 1)}$$

- Load/generator side:

$$\begin{cases} I^{l+1} - I^{l+\frac{1}{2}} = \beta(V^{l+1} - V^{l+\frac{1}{2}}), \\ (V^{l+1})^{*} I^{l+1} = S^{*}. \end{cases} \quad \text{(Eq. 2)}$$

Matrices α and β can be arbitrarily defined, but for instance:

$$\begin{cases} \alpha = \text{diag}(S^{*}/|V|^{2}), \\ \beta = \text{diag}(Y + \alpha). \end{cases} \quad \text{(Eq. 3)}$$

These are constant matrices. Contrary to the typical NR, there are no inverses as such (expensive computation with $\mathcal{O}(n^3)$).

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Multidimensional power flow

- Dimensions: position (nodes), changes in power, time...
- Voltages expressed in the separated form: $V(x,q,t) = \sum_{m=1}^{M} V_m \otimes Q_m \otimes T_m$.

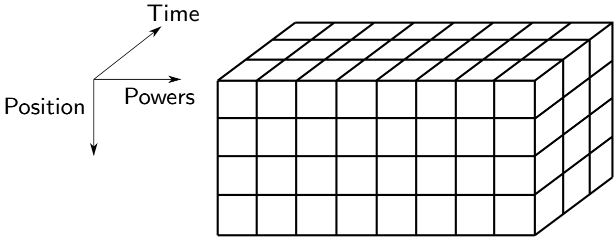

Figure 1. Representation of the cube of solutions

- Need to compute $M(n_{\text{buses}} + n_{\text{powers}} + n_{\text{time}})$ instead of $n_{\text{buses}} \cdot n_{\text{powers}} \cdot n_{\text{time}}$ cases.
- Can it be adapted for changes in the topology so that we can employ it for contingency analysis ($N-1$, $N-2$...)?

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Algorithm

The outer loop follows the ASD procedure while the inner one is based on the alternating directions technique.

Algorithm 1 Pseudocode for the PGD combined with ASD

```
for γ = 1 to N_γ do
    Compute power side of the problem with PGD: I = S* ⊘ V*[γ]
    for m = 1 to M do
        Define I = Σ_{m=1}^{M-1} I_m ⊗ Q_m ⊗ T_m + I_M ⊗ Q_M ⊗ T_M
        for k = 1 to N_k do
            Compute I_M^[k+1] with Q_M^[k] and T_M^[k].
            Compute Q_M^[k+1] with I_M^[k+1] and T_M^[k].
            Compute T_M^[k+1] with I_M^[k+1] and Q_M^[k+1].
        end for
    end for
    Compute admittances side of the problem directly: V^[γ+1] = Y^{-1}(I + I_0).
end for
```

- Show code and results.

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